

Remarks

The Office Action mailed May 7, 2003, has been received and reviewed. Claims 1, 15-17, and 26 having been amended, and claims 27-29 having been added, the pending claims are claims 1-29. Reconsideration and withdrawal of the rejections are respectfully requested. Support for the amendment to claims 1, 16, 17, and 26 can be found in the example at page 15. Support for the amendment to claim 15 and for new claims 27-29 can be found in the specification at page 9, lines 13-15.

The 35 U.S.C. §102(e) Rejection

The Examiner rejected claim 15 under 35 U.S.C. §102(e) as being anticipated by Beitel et al. (U.S. 2002/0017063 A1). This rejection is respectfully traversed.

Claim 15 has been amended to recite that the polishing surface comprises a fixed abrasive article or a polishing pad, and when the polishing surface comprises a polishing pad the planarization composition comprises a plurality of abrasive particles having a hardness of no greater than 9 Mohs.

Beitel et al. do not teach or suggest the use of a fixed abrasive article as recited in Applicants' claim 15. Furthermore, there is no motivation to modify Beitel et al. to use a fixed abrasive article. Methods that use a polishing pad and an abrasive slurry, which is what is disclosed in Beitel et al., are not necessarily readily converted to the use of a fixed abrasive article with the expectation of similar results.

Also, Beitel et al. do not teach or suggest a planarization method that uses a polishing pad and a planarization composition that includes abrasive particles having a hardness of no greater than 9 Mohs (as recited in Applicants' claim 15). Beitel et al. teach the use of diamond. Diamond has a hardness of greater than 9 (see Exhibit A, which indicates that silicon carbide has a hardness of 9+ Mohs, and states that this hardness is "just under diamond"). Furthermore, there is no motivation to modify Beitel et al. to replace the diamond with abrasive particles having a hardness of no greater than 9 Mohs. Even if there were such motivation, there

is no expectation of success. Not all abrasive particles necessarily work the same with respect to removal rates and/or incorporation of defects, for example. Withdrawal of this rejection is respectfully requested.

The 35 U.S.C. §103(a) Rejections

The Examiner rejected claims 1-6, 10-14, 16-19, and 22-26 under 35 U.S.C. §103(a) as being unpatentable over Beitel et al. in view of Weast et al. ("CRC Handbook of Chemistry and Physics"). This rejection is respectfully traversed.

The Examiner rejected claims 1, 7-9, 17, and 20-21 under 35 U.S.C. §103(a) as being unpatentable over Russell et al. (U.S. Patent 6,395,194) in view of Weast et al. This rejection is respectfully traversed.

Independent claims 1, 16, 17, and 26 have been amended to recite that the oxidizing agent is added to the planarization composition in the form of a gas. In contrast, Russel et al. generate a gas (e.g., Br₂) *in situ*. See, for example, column 5, lines 64-67. Beitel et al. discloses the use of oxygen and ozone, but is silent as to how they are added. See, for example, column 2, paragraph 20. Thus, neither Beitel et al. or Russel et al. teaches or suggests the addition of the oxidizing agent as a gas. Such a method of preparing the planarization composition provides advantages over *in situ* generation of the gas, for example. One such advantage is the better control of the amount of oxidizing gas incorporated into the planarization composition.

Weast et al. do not teach that which is missing from Beitel et al. or Russel et al. And, there is no motivation to modify any of these three documents to come up with Applicants' invention. Withdrawal of these rejections are respectfully requested.

Amendment and Response

Page 10 of 10

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Filed: December 21, 2001

For: METHODS FOR PLANARIZATION OF GROUP VIII METAL-CONTAINING SURFACES USING
OXIDIZING GASES

Summary

It is respectfully submitted that the pending claims 1-29 are in condition for allowance and notification to that effect is respectfully requested. The Examiner is invited to contact Applicants' Representatives, at the below-listed telephone number, if it is believed that prosecution of this application may be assisted thereby.

Respectfully submitted for
Uhlenbrock et al.

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CERTIFICATE UNDER 37 CFR §1.10:

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I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR §1.10 on the date indicated above and is addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

By: Jill R. Aguilar
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Tech Bulletin

Micro-Abrasive Media Selection Guide

Page 1 of 3

Abrasive Selection Guide

The effect of an abrasive material is caused by its three characteristics: shape, hardness, and particle size. The micro-abrasive media needed for a particular task is determined by the action or "effect" it produces.

Particle Shape - Individual particles that have points and edges such as blocky or needle shaped particles will cut and strip away surface material on impact. Spherical shaped particles do not have any cutting edges and are used to pound or "peen" a surface.

Hardness - The hardness of a selected media determines the ability of the particle to remove layers of the work piece material. Harder particles will be more aggressive. The hardness of abrasive media is measured using the Moh's scale.

Particle Size - A larger particle generates a greater impact force as it strikes the work piece. This has two effects. The first is that it removes material faster. The second is that it tends to produce a heavier texture or rougher surface on the base material.



Aluminum Oxide

Particle Size		Particle Shape	Hardness (Moh's)
Micron	Inch		
10	0.0004	Blocky & Sharp	9
17.5	0.0007		
25	0.001		
50	0.002		
100	0.004		
150	0.006		

Description: Aluminum oxide is the most commonly used cutting abrasive. The shape and hardness of the particle make it an excellent choice when working with metals or hard brittle parts. Common uses for aluminum oxide include cutting, deburring and the preparation of surfaces. It is available in a wide range of sizes from 10 to 150 microns.

Micro-Abrasive Media Selection Guide

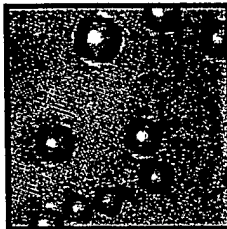
Page 2 of 3



Crushed Glass

Particle Size		Particle Shape	Hardness (Moh's)
Micron	Inch	Blocky & Sharp	Between 5 and 6
50	0.002		

Description: This media is manufactured by crushing glass beads. The result is a mild abrasive media. It has the hardness of glass bead, 5 to 6 on the Moh's scale, with lots of shard-like edges. Crushed glass is used where only a light degree of abrading is desired.



Glass Bead

Particle Size		Particle Shape	Hardness (Moh's)
Micron	Inch	Spherical	6
50	0.002		

Description: Glass bead is commonly used where the preservation of tight tolerances is critical combined with the need to relieve machined stresses. It is also used to perform light deburring or to apply a satin-like finish on a part. The spherical shape of the glass bead keeps it from cutting into the surface of a part, so it is commonly used to relieve stresses by "pounding" the part's surface.



Plastic Media

Particle Size		Particle Shape	Hardness (Moh's)
Micron	Inch	Blocky	Between 2 and 4
200	0.008		

Description: This media is obtained by grinding and carefully sizing recycled plastic. It has a size similar to that of walnut shell. Its size makes it an effective tool to deburr machined plastic parts without causing dimensional changes. Plastic media can also be used to remove conformal coatings.



Silicon Carbide

Particle Size		Particle Shape	Hardness (Moh's)
Micron	Inch	Blocky & Sharp	9 +
20	0.0008		
50	0.002		

Description: This is the most aggressive media used for micro-abrasive blasting. It has a hardness over 9 on the Moh's scale, just under diamond. This media is typically used only where very fast material removal is a requirement. Silicon carbide is an excellent abrasive for deburring stainless steel and titanium parts.





Sodium Bicarbonate

Particle Size		Particle Shape	Hardness (Moh's)
Micron	Inch	Monoclinic	Between 3 and 4
50	0.002		

Description: Sodium bicarbonate is one of the softest abrasives available, but the particles' needle-like or "monoclinic" shape makes it an excellent choice for abrading more pliable materials. The particles cut through soft surfaces where a blockier particle would tend to bounce off. It is commonly used to selectively remove the coating on a circuit board without damaging the individual components.



Walnut Shell

Particle Size		Particle Shape	Hardness (Moh's)
Micron	Inch	Blocky	Between 3 and 4
250	0.010		

Description: Walnut shell is manufactured by grinding nut shells. It has a much larger size than sodium bicarbonate, approximately 200 to 250 microns. Walnut shell will quickly remove polymer coatings from circuit board surfaces and can also be used to deflash plastic parts.

Selection of the Correct Abrasive Media

The selection of a particular media is always dictated by the type of work to be performed and what material will be treated. As this chart outlines, abrasive media ranges from soft sodium bicarbonate to hard silicon carbide.

Media used in micro-abrasive blasting is very different from anything used in a larger "grit" blaster. The micro-abrasive blasting media must be free of impurities and dry with a typical moisture content of less than 1%.

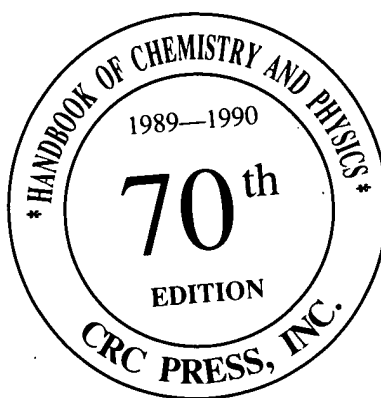
The Technical Support team at Comco has been specially trained to supply our customers with the correct solutions to a multitude of applications. They can confidently recommend the best abrasive media for specific uses across a wide variety of industries.



Additional information on Micro-Abrasive Media may be found in other Comco Technical Bulletins including "Micro-Abrasive Blasting Recycling Issues" and "Moisture Issues: The Importance of Clean, Dry Air."

CRC Handbook of Chemistry and Physics

A Ready-Reference Book of Chemical and Physical Data



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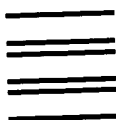
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CONVERSION FORMULAE FOR SOLUTIONS HAVING CONCENTRATIONS EXPRESSED IN VARIOUS WAYS

A = Weight per cent of solute
B = Molecular weight of solvent
E = Molecular weight of solute
F = Grams of solute per liter of solution
G = Molality
M = Molarity
N = Mole fraction
R = Density of solution grams per cc

Concentration of solute— SOUGHT	Concentration of solute—GIVEN				
	A	N	G	M	F
A	—	$\frac{100N \times E}{N \times E + (1 - N)B}$	$\frac{100G \times E}{1000 + G \times E}$	$\frac{M \times E}{10R}$	$\frac{F}{10R}$
N	$\frac{A}{E} + \frac{100 - A}{B}$	—	$\frac{B \times G}{B \times G + 1000}$	$\frac{B \times M}{M(B - E) + 1000R}$	$\frac{B \times F}{F(B - E) + 1000R \times E}$
G	$\frac{1000A}{E(100 - A)}$	$\frac{1000N}{B - N \times B}$	—	$\frac{1000M}{1000R - (M \times E)}$	$\frac{1000F}{E(1000R - F)}$
M	$\frac{10R \times A}{E}$	$\frac{1000R \times N}{N \times E + (1 - N)B}$	$\frac{1000R \times G}{1000 + E \times G}$	—	$\frac{F}{E}$
F	10AR	$\frac{1000R \times N \times E}{N \times E + (1 - N)B}$	$\frac{1000R \times G \times E}{1000 + G \times E}$	M × E	—

ELECTROCHEMICAL SERIES

Petr Vanýsek

There are three tables for this Electrochemical Series. Each table lists standard reduction potentials, E° values, at 298.15 K (25°C), and at a pressure of 101.325 kPa (1 atm.). Table 1 is an alphabetical listing of the elements according to the symbols for the elements. Thus, data for Silver (Ag) precedes those for Aluminum (Al). Table 2 lists only those reduction reactions which have E° values positive to the potential of the Standard Hydrogen Electrode. In Table 2, the reactions are listed in the order of increasing positive potential and range from 0.000 V to +3.053 V. Table 3 lists only those reduction reactions which have E° values negative to the potential of the Standard Hydrogen Electrode. In Table 3, reactions are listed in the order of increasing negative potential and range from -0.017 to -4.10 V.

Table 1
ALPHABETICAL LISTING

Reaction	E°, V	Reaction	E°, V
Ag ⁺ + e ⇌ Ag	0.7996	Ag ₂ WO ₄ + 2 e ⇌ 2 Ag + WO ₄ ²⁻	0.4660
Ag ²⁺ + e ⇌ Ag ⁺	1.980	Al ³⁺ + 3 e ⇌ Al	-1.662
Ag(ac) + e ⇌ Ag + (ac) ⁻	0.643	H ₂ AlO ₃ ⁻ + H ₂ O + 3 e ⇌ Al + 4 OH ⁻	-2.33
AgBr + e ⇌ Ag + Br ⁻	0.07133	AlF ₆ ³⁻ + 3 e ⇌ Al + 6 F ⁻	-2.069
AgBrO ₃ + e ⇌ Ag + BrO ₃ ⁻	0.546	As + 3H ⁺ + 3 e ⇌ AsH ₃	-0.608
Ag ₂ C ₂ O ₄ + 2 e ⇌ 2Ag + C ₂ O ₄ ²⁻	0.4647	As ₂ O ₃ + 6 H ⁺ + 6 e ⇌ 2 As + 3 H ₂ O	0.234
AgCl + e ⇌ Ag + Cl ⁻	0.22233	HAsO ₂ + 3 H ⁺ + 3 e ⇌ As + 2 H ₂ O	0.248
AgCN + e ⇌ Ag + CN ⁻	-0.017	AsO ₂ ⁻ + 2 H ₂ O + 3 e ⇌ As + 4 OH ⁻	-0.68
Ag ₂ CO ₃ + 2 e ⇌ 2 Ag + CO ₃ ²⁻	0.47	H ₃ AsO ₄ + 2 H ⁺ + 2 e ⇌ HAsO ₂ + 2 H ₂ O	0.560
Ag ₂ CrO ₄ + 2 e ⇌ 2 Ag + CrO ₄ ²⁻	0.4470	AsO ₄ ³⁻ + 2 H ₂ O + 2 e ⇌ AsO ₂ ⁻ + 4 OH ⁻	-0.71
AgF + e ⇌ Ag + F ⁻	0.779	Au ⁺ + e ⇌ Au	1.692
Ag ₄ [Fe(CN) ₆] + 4 e ⇌ 4 Ag + [Fe(CN) ₆] ⁴⁻	0.1478	Au ³⁺ + 2 e ⇌ Au ⁺	1.401
AgI + e ⇌ Ag + I ⁻	-0.15224	Au ³⁺ + 3 e ⇌ Au	1.498
AgIO ₃ + e ⇌ Ag + IO ₃ ⁻	0.354	AuBr ₂ ⁻ + e ⇌ Au + 2 Br ⁻	0.959
Ag ₂ MoO ₄ + 2 e ⇌ 2 Ag + MoO ₄ ²⁻	0.4573	AuBr ₄ ⁻ + 3 e ⇌ Au + 4 Br ⁻	0.854
AgNO ₂ + e ⇌ Ag + NO ₂ ⁻	0.564	AuCl ₄ ⁻ + 3 e ⇌ Au + 4 Cl ⁻	1.002
Ag ₂ O + H ₂ O + 2 e ⇌ 2 Ag + 2 OH ⁻	0.342	Au(OH) ₃ + 3 H ⁺ + 3 e ⇌ Au + 3 H ₂ O	1.45
Ag ₂ O ₃ + H ₂ O + 2 e ⇌ 2 AgO + 2 OH ⁻	0.739	H ₂ BO ₃ ⁻ + 5 H ₂ O + 8 e ⇌ BH ₄ ⁻ + 8 OH ⁻	-1.24
Ag ₂ O + H ₂ O + 2 e ⇌ Ag ₂ O + 2 OH ⁻	0.607	H ₂ BO ₃ ⁻ + H ₂ O + 3 e ⇌ B + 4 OH ⁻	-1.79
AgOCN + e ⇌ Ag + OCN ⁻	0.41	H ₃ BO ₃ + 3 H ⁺ + 3 e ⇌ B + 3 H ₂ O	-0.8698
Ag ₂ S + 2 e ⇌ 2 Ag + S ²⁻	-0.691	Ba ²⁺ + 2 e ⇌ Ba	-2.912
Ag ₂ S + 2 H ⁺ + 2 e ⇌ 2 Ag + H ₂ S	-0.0366	Ba ²⁺ + 2 e ⇌ Ba(Hg)	-1.570
AgSCN + e ⇌ Ag + SCN ⁻	0.08951	Ba(OH) ₂ + 2 e ⇌ Ba + 2 OH ⁻	-2.99
Ag ₂ SeO ₃ + 2 e ⇌ 2 Ag + SeO ₃ ²⁻	0.3629	Be ²⁺ + 2 e ⇌ Be	-1.847
Ag ₂ SO ₃ + 2 e ⇌ 2 Ag + SO ₃ ²⁻	0.654	Be ₂ O ₃ ²⁻ + 3 H ₂ O + 4 e ⇌ 2 Be + 6 OH ⁻	-2.63

Table 1 (continued)
ALPHABETICAL LISTING

Reaction	E°, V	Reaction	E°, V	Reaction	E°, V
p-benzoquinone + 2 H ⁺ + 2 e ⁻ ⇌ hydroquinone	0.6992	Co ³⁺ + e ⁻ ⇌ Co ²⁺ (2 mol/l H ₂ SO ₄)	1.83	Hg ₂ (ac) ₂ + 2 e ⁻ ⇌ Hg ₂ Br ₂ + 2 e ⁻	
BiCl ₄ ⁻ + 3 e ⁻ ⇌ Bi + 4 Cl ⁻	0.16	[Co(NH ₃) ₆] ³⁺ + e ⁻ ⇌ [Co(NH ₃) ₆] ²⁺	0.108	Hg ₂ Cl ₂ + 2 e ⁻ ⇌ Hg ₂ HPO ₄ + 2 e ⁻	
Bi ₂ O ₃ + 3 H ₂ O + 6 e ⁻ ⇌ 2 Bi + 6 OH ⁻	-0.46	Co(OH) ₂ + 2 e ⁻ ⇌ Co + 2 OH ⁻	-0.73	Hg ₂ I ₂ + 2 e ⁻ ⇌ Hg ₂ O + 11 H ₂ O	
Bi ₂ O ₄ + 4 H ⁺ + 2 e ⁻ ⇌ 2 BiO ⁺ + 2 H ₂ O	1.593	Co(OH) ₃ + e ⁻ ⇌ Co(OH) ₂ + OH ⁻	0.17	Hg ₂ SO ₄ + 2 e ⁻ ⇌ I ₂ + 2 e ⁻ + 2 e ⁻	
BiO ⁺ + 2 H ⁺ + 3 e ⁻ ⇌ Bi + H ₂ O	0.320	CO ₂ + 2 H ⁺ + 2 e ⁻ ⇌ HCOOH	-0.199	I ₂ + 2 e ⁻ ⇌ 2 I ⁻	
BiOCl + 2 H ⁺ + 3 e ⁻ ⇌ Bi + Cl ⁻ + H ₂ O	0.1583	Cr ²⁺ + 2 e ⁻ ⇌ Cr	-0.913	I ₂ + 2 e ⁻ ⇌ 2 I ⁻	
Br ₂ (aq) + 2 e ⁻ ⇌ 2 Br ⁻	1.0873	Cr ³⁺ + e ⁻ ⇌ Cr ²⁺	-0.407	I ₂ + 2 e ⁻ ⇌ 2 I ⁻	
Br ₂ (l) + 2 e ⁻ ⇌ 2 Br ⁻	1.066	Cr ³⁺ + 3 e ⁻ ⇌ Cr	-0.744	H ₂ IO ₆ + 2 e ⁻ ⇌ H ₂ IO ₆ + 11 H ⁺	
HBrO + H ⁺ + 2 e ⁻ ⇌ Br ⁻ + H ₂ O	1.331	Cr ₂ O ₇ ²⁻ + 14 H ⁺ + 6 e ⁻ ⇌ 2 Cr ³⁺ + 7 H ₂ O	1.232	2 HIO + 2 H ⁺ ⇌ HIO + H ⁺	
HBrO + H ⁺ + e ⁻ ⇌ 1/2 Br ₂ (aq) + H ₂ O	1.574	CrO ₂ ⁻ + 2 H ₂ O + 3 e ⁻ ⇌ Cr + 4 OH ⁻	-1.2	IO ⁻ + H ₂ O ⇌ IO ₃ ⁻ + 12 H ⁺	
HBrO + H ⁺ + e ⁻ ⇌ 1/2 Br ₂ (l) + H ₂ O	1.596	HCrO ₄ ⁻ + 7 H ⁺ + 3 e ⁻ ⇌ Cr ³⁺ + 4 H ₂ O	1.350	IO ₃ ⁻ + 6 H ⁺ ⇌ IO ₃ ⁻ + 2 H ₂ O	
BrO ⁻ + H ₂ O + 2 e ⁻ ⇌ Br ⁻ + 2 OH ⁻	0.761	CrO ₄ ²⁻ + 4 H ₂ O + 3 e ⁻ ⇌ Cr(OH) ₃ + 5 OH ⁻	-0.13	IO ₃ ⁻ + 3 H ₂ O ⇌ In ³⁺ + e ⁻	
BrO ₃ ⁻ + 6 H ⁺ + 5 e ⁻ ⇌ 1/2 Br ₂ + 3 H ₂ O	1.482	Cr(OH) ₃ + 3 e ⁻ ⇌ Cr + 3 OH ⁻	-1.48	In ³⁺ + 2 e ⁻ ⇌ In ³⁺ + 3 e ⁻	
BrO ₃ ⁻ + 6 H ⁺ + 6 e ⁻ ⇌ Br ⁻ + 3 H ₂ O	1.423	Cs ⁺ + e ⁻ ⇌ Cs	-2.92	In ³⁺ + 3 e ⁻ ⇌ Ir ³⁺ + 3 e ⁻	
BrO ₃ ⁻ + 3 H ₂ O + 6 e ⁻ ⇌ Br ⁻ + 6 OH ⁻	0.61	Cu ⁺ + e ⁻ ⇌ Cu	0.521	Ir ₂ O ₃ + 3 H ₂ O ⇌ K ⁺ + e ⁻	
Ca ²⁺ + e ⁻ ⇌ Ca	-3.80	Cu ²⁺ + e ⁻ ⇌ Cu ⁺	0.153	La ³⁺ + 3 e ⁻ ⇌ Li ⁺ + e ⁻	
Calomel electrode, 1 molal KCl	-2.868	Cu ²⁺ + 2 e ⁻ ⇌ Cu	0.3419	Mg ²⁺ + 2 e ⁻ ⇌ Mg(OH) ₂ + 2 e ⁻	
Calomel electrode, 1 mol/l KCl (NCE)	0.2800	Cu ²⁺ + 2 e ⁻ ⇌ Cu(Hg)	0.345	Mn ²⁺ + 2 e ⁻ ⇌ Mn ²⁺ + 3 e ⁻	
Calomel electrode, 0.1 mol/l KCl	0.2801	Cu ²⁺ + 2 CN ⁻ + e ⁻ ⇌ [Cu(CN) ₂] ⁻	1.103	MnO ₂ + 4 e ⁻ ⇌ MnO ₄ ⁻ + 4 e ⁻	
Calomel electrode, saturated KCl (SCE)	0.3337	Cu ₂ ⁺ + e ⁻ ⇌ Cu + 2 I ⁻	0.00	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Calomel electrode, saturated NaCl (SSCE)	0.2412	Cu ₂ O + H ₂ O + 2 e ⁻ ⇌ 2 Cu + 2 OH ⁻	-0.360	MnO ₄ ⁻ + 2 e ⁻ ⇌ Mn(OH) ₂ + 2 e ⁻	
Calomel electrode, saturated NaCl (SSCE)	0.2360	Cu(OH) ₂ + 2 e ⁻ ⇌ Cu + 2 OH ⁻	-0.222	Mn ²⁺ + 2 e ⁻ ⇌ Mn ²⁺ + 3 e ⁻	
Ca(OH) ₂ + 2 e ⁻ ⇌ Ca + 2 OH ⁻	-3.02	2 Cu(OH) ₂ + 2 e ⁻ ⇌ Cu ₂ O + 2 OH ⁻ + H ₂ O	-0.080	Mn ²⁺ + 3 e ⁻ ⇌ MnO ₂ + 4 e ⁻	
Cd ²⁺ + 2 e ⁻ ⇌ Cd	-0.4030	D ⁺ + e ⁻ ⇌ 1/2 D ₂	-0.003	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Cd ²⁺ + 2 e ⁻ ⇌ Cd(Hg)	-0.3521	2 D ⁺ + 2 e ⁻ ⇌ D ₂	-0.044	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Cd(OH) ₂ + 2 e ⁻ ⇌ Cd(Hg) + 2 OH ⁻	-0.809	Eu ²⁺ + 2 e ⁻ ⇌ Eu	-3.393	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
CdSO ₄ + 2 e ⁻ ⇌ Cd + SO ₄ ²⁻	-0.246	Eu ³⁺ + 3 e ⁻ ⇌ Eu	-2.407	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Ce ³⁺ + 3 e ⁻ ⇌ Ce	-2.483	Eu ³⁺ + e ⁻ ⇌ Eu ²⁺	-0.36	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Ce ³⁺ + 3 e ⁻ ⇌ Ce(Hg)	-1.4373	F ₂ + 2 H ⁺ + 2 e ⁻ ⇌ 2 HF	3.053	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Ce ⁴⁺ + e ⁻ ⇌ Ce ³⁺	1.61	F ₂ + 2 e ⁻ ⇌ 2 F ⁻	2.866	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
CeOH ³⁺ + H ⁺ + e ⁻ ⇌ Ce ³⁺ + H ₂ O	1.715	F ₂ O + 2 H ⁺ + 4 e ⁻ ⇌ H ₂ O + 2 F ⁻	2.153	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Cl ₂ (g) + 2 e ⁻ ⇌ Cl ⁻	1.35827	Fe ²⁺ + 2 e ⁻ ⇌ Fe	-0.447	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
HClO + H ⁺ + e ⁻ ⇌ 1/2 Cl ₂ + H ₂ O	1.611	Fe ³⁺ + 3 e ⁻ ⇌ Fe	-0.037	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
HClO + H ⁺ + 2 e ⁻ ⇌ Cl ⁻ + H ₂ O	1.482	Fe ³⁺ + e ⁻ ⇌ Fe ²⁺	0.771	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ⁻ + H ₂ O + 2 e ⁻ ⇌ Cl ⁻ + 2 OH ⁻	0.81	[Fe(CN) ₆] ³⁻ + e ⁻ ⇌ [Fe(CN) ₆] ⁴⁻	0.353	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₂ + H ⁺ + e ⁻ ⇌ HClO ₂	1.277	FeO ₄ ²⁻ + 8 H ⁺ + 3 e ⁻ ⇌ Fe ³⁺ + 4 H ₂ O	2.22	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
HClO ₂ + 2 H ⁺ + 2 e ⁻ ⇌ HClO + H ₂ O	1.645	Fe(OH) ₃ + e ⁻ ⇌ Fe(OH) ₂ + OH ⁻	0.08	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
HClO ₂ + 3 H ⁺ + 3 e ⁻ ⇌ 1/2 Cl ₂ + 2 H ₂ O	1.628	[Fe(phenanthroline) ₃] ³⁺ + e ⁻ ⇌ [Fe(phen) ₃] ²⁺	1.11	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
HClO ₂ + 3 H ⁺ + 4 e ⁻ ⇌ Cl ⁻ + 2 H ₂ O	1.570	[Fe(phen) ₃] ³⁺ + e ⁻ ⇌ [Fe(phen) ₃] ²⁺ (1 mol/l H ₂ SO ₄)	1.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₂ ⁻ + H ₂ O + 2 e ⁻ ⇌ Cl ⁻ + 2 OH ⁻	0.66	[Ferricinium] ⁺ + e ⁻ ⇌ ferrocene	0.4	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₂ ⁻ + 2 H ₂ O + 4 e ⁻ ⇌ Cl ⁻ + 4 OH ⁻	0.76	Ga ³⁺ + 3 e ⁻ ⇌ Ga	-0.5	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₂ (aq) + e ⁻ ⇌ ClO ₂ ⁻	0.954	H ₂ GaO ₃ + H ₂ O + 3 e ⁻ ⇌ Ga + 4 OH ⁻	-1.2	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₃ ⁻ + 2 H ⁺ + e ⁻ ⇌ ClO ₂ + H ₂ O	1.152	Ge ²⁺ + 2 e ⁻ ⇌ Ge	0.1	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₃ ⁻ + 3 H ⁺ + 2 e ⁻ ⇌ HClO ₂ + H ₂ O	1.214	Ge ⁴⁺ + 4 e ⁻ ⇌ Ge	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₃ ⁻ + 6 H ⁺ + 5 e ⁻ ⇌ 1/2 Cl ₂ + 3 H ₂ O	1.47	Ge ⁴⁺ + 2 e ⁻ ⇌ Ge ²⁺	-0.6	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₃ ⁻ + 6 H ⁺ + 6 e ⁻ ⇌ Cl ⁻ + 3 H ₂ O	1.451	GeO ₂ + 2 H ⁺ + 2 e ⁻ ⇌ GeO + H ₂ O	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₃ ⁻ + H ₂ O + 2 e ⁻ ⇌ ClO ₂ ⁻ + 2 OH ⁻	0.33	H ₂ GeO ₃ + 4 H ⁺ + 4 e ⁻ ⇌ Ge + 3 H ₂ O	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₃ ⁻ + 3 H ₂ O + 6 e ⁻ ⇌ Cl ⁻ + 6 OH ⁻	0.62	2 H ⁺ + 2 e ⁻ ⇌ H ₂	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₄ ⁻ + 2 H ⁺ + 2 e ⁻ ⇌ ClO ₃ ⁻ + H ₂ O	1.189	H ₂ + 2 e ⁻ ⇌ 2 H ⁻	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₄ ⁻ + 8 H ⁺ + 7 e ⁻ ⇌ 1/2 Cl ₂ + 4 H ₂ O	1.39	HO ₂ + H ⁺ + e ⁻ ⇌ H ₂ O ₂	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₄ ⁻ + 8 H ⁺ + 8 e ⁻ ⇌ Cl ⁻ + 4 H ₂ O	1.389	2 H ₂ O + 2 e ⁻ ⇌ H ₂ + 2 OH ⁻	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
ClO ₄ ⁻ + H ₂ O + 2 e ⁻ ⇌ ClO ₃ ⁻ + 2 OH ⁻	0.36	H ₂ O ₂ + 2 H ⁺ + 2 e ⁻ ⇌ 2 H ₂ O	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
(CN) ₂ + 2 H ⁺ + 2 e ⁻ ⇌ 2 HCN	0.373	HfO ₂ ²⁺ + 2 H ⁺ + 4 e ⁻ ⇌ Hf + H ₂ O	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
2 HCNO + 2 H ⁺ + 2 e ⁻ ⇌ (CN) ₂ + 2 H ₂ O	0.77	HfO ₂ + 4 H ⁺ + 4 e ⁻ ⇌ Hf + 2 H ₂ O	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
(CNS) ₂ + 2 e ⁻ ⇌ 2 CNS ⁻	-0.28	HfO(OH) ₂ + H ₂ O + 4 e ⁻ ⇌ Hf + 4 OH ⁻	0.0	MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
Co ²⁺ + 2 e ⁻ ⇌ Co		Hg ²⁺ + 2 e ⁻ ⇌ Hg		MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
		2 Hg ²⁺ + 2 e ⁻ ⇌ Hg ₂ ²⁺		MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	
		Hg ₂ ²⁺ + 2 e ⁻ ⇌ 2 Hg		MnO ₄ ⁻ + 2 e ⁻ ⇌ MnO ₄ ⁻ + 2 e ⁻	

Table 1 (continued)
ALPHABETICAL LISTING

Reaction	E°, V	Reaction	E°, V	Reaction	E°, V
$\text{PbSO}_4 + 2e \rightleftharpoons \text{Pb(Hg)} + \text{SO}_4^{2-}$	-0.3505	$\text{Se} + 2\text{H}^+ + 2e \rightleftharpoons \text{H}_2\text{Se(aq)}$	-0.39	$\text{WO}_2 + 4\text{H}^+ + 4e \rightleftharpoons \text{W} + 2\text{H}_2\text{O}$	-0.10
$\text{Pd}^{2+} + 2e \rightleftharpoons \text{Pd}$	0.951	$\text{H}_2\text{SeO}_3 + 4\text{H}^+ + 4e \rightleftharpoons \text{Se} + 3\text{H}_2\text{O}$	-0.74	$\text{WO}_3 + 6\text{H}^+ + 6e \rightleftharpoons \text{W} + 3\text{H}_2\text{O}$	-0.10
$[\text{PdCl}_4]^{2-} + 2e \rightleftharpoons \text{Pd} + 4\text{Cl}^-$	0.591	$\text{SeO}_3^{2-} + 3\text{H}_2\text{O} + 4e \rightleftharpoons \text{Se} + 6\text{OH}^-$	-0.36	$2\text{WO}_3 + 2\text{H}^+ + 2e \rightleftharpoons \text{W}_2\text{O}_5 + \text{H}_2\text{O}$	-0.10
$[\text{PdCl}_6]^{2-} + 2e \rightleftharpoons [\text{PdCl}_4]^{2-} + 2\text{Cl}^-$	1.288	$\text{SeO}_2^{2-} + 4\text{H}^+ + 2e \rightleftharpoons \text{H}_2\text{SeO}_3 + \text{H}_2\text{O}$	-0.11	$\text{Y}^{3+} + 3e \rightleftharpoons \text{Y}$	-0.10
$\text{Pd(OH)}_2 + 2e \rightleftharpoons \text{Pd} + 2\text{OH}^-$	0.07	$\text{SeO}_2^{2-} + \text{H}_2\text{O} + 2e \rightleftharpoons \text{SeO}_3^{2-} + 2\text{OH}^-$	0.05	$\text{Zn}^{2+} + 2e \rightleftharpoons \text{Zn}$	-0.76
$\text{Pt}^{2+} + 2e \rightleftharpoons \text{Pt}$	1.118	$\text{SiF}_6^{2-} + 4e \rightleftharpoons \text{Si} + 6\text{F}^-$	-1.24	$\text{Zn}^{2+} + 2e \rightleftharpoons \text{Zn(l)}$	-0.76
$[\text{PtCl}_4]^{2-} + 2e \rightleftharpoons \text{Pt} + 4\text{Cl}^-$	0.755	$\text{SiO}_2 \text{ (quartz)} + 4\text{H}^+ + 4e \rightleftharpoons \text{Si} + 2\text{H}_2\text{O}$	0.85		
$[\text{PtCl}_6]^{2-} + 2e \rightleftharpoons [\text{PtCl}_4]^{2-} + 2\text{Cl}^-$	0.68	$\text{SiO}_3^{2-} + 3\text{H}_2\text{O} + 4e \rightleftharpoons \text{Si} + 6\text{OH}^-$	-1.69		
$\text{Pt(OH)}_2 + 2e \rightleftharpoons \text{Pt} + 2\text{OH}^-$	0.14	$\text{Sn}^{2+} + 2e \rightleftharpoons \text{Sn}$	-0.13		
$\text{Pu}^{3+} + 3e \rightleftharpoons \text{Pu}$	-2.031	$\text{Sn}^{4+} + 2e \rightleftharpoons \text{Sn}^{2+}$	0.15		
$\text{Pu}^{4+} + e \rightleftharpoons \text{Pu}^{3+}$	1.006	$\text{HSnO}_2^- + \text{H}_2\text{O} + 2e \rightleftharpoons \text{Sn} + 3\text{OH}^-$	-0.90		
$\text{Pu}^{5+} + e \rightleftharpoons \text{Pu}^{4+}$	1.099	$\text{Sn(OH)}_6^{2-} + 2e \rightleftharpoons \text{HSnO}_2^- + 3\text{OH}^- + \text{H}_2\text{O}$	-0.93		
$\text{PuO}_2(\text{OH})_2 + 2\text{H}^+ + 2e \rightleftharpoons \text{Pu(OH)}_4$	1.325				
$\text{PuO}_2(\text{OH})_2 + \text{H}^+ + e \rightleftharpoons \text{PuO}_2\text{OH} + \text{H}_2\text{O}$	1.062				
$\text{Rb}^+ + e \rightleftharpoons \text{Rb}$	-2.98	$\text{Sr}^+ + e \rightleftharpoons \text{Sr}$	-4.10		
$\text{Re}^{3+} + 3e \rightleftharpoons \text{Re}$	0.300	$\text{Sr}^{2+} + 2e \rightleftharpoons \text{Sr}$	-2.89		
$\text{ReO}_4^- + 4\text{H}^+ + 3e \rightleftharpoons \text{ReO}_2 + 2\text{H}_2\text{O}$	0.510	$\text{Sr}^{2+} + 2e \rightleftharpoons \text{Sr(Hg)}$	-1.79		
$\text{ReO}_2 + 4\text{H}^+ + 4e \rightleftharpoons \text{Re} + 2\text{H}_2\text{O}$	0.2513	$\text{Sr(OH)}_2 + 2e \rightleftharpoons \text{Sr} + 2\text{OH}^-$	-2.88		
$\text{ReO}_4^- + 2\text{H}^+ + e \rightleftharpoons \text{ReO}_3 + \text{H}_2\text{O}$	0.768	$\text{Ta}_2\text{O}_5 + 10\text{H}^+ + 10e \rightleftharpoons 2\text{Ta} + 5\text{H}_2\text{O}$	-0.75		
$\text{ReO}_4^- + 4\text{H}_2\text{O} + 7e \rightleftharpoons \text{Re} + 8\text{OH}^-$	-0.584	$\text{Tc}^{2+} + 2e \rightleftharpoons \text{Tc}$	0.400		
$\text{ReO}_4^- + 8\text{H}^+ + 7e \rightleftharpoons \text{Re} + 4\text{H}_2\text{O}$	0.368	$\text{TcO}_4^- + 4\text{H}^+ + 3e \rightleftharpoons \text{TcO}_2 + 2\text{H}_2\text{O}$	0.782		
$\text{Rh}^+ + e \rightleftharpoons \text{Rh}$	0.600	$\text{Te} + 2e \rightleftharpoons \text{Te}^{2-}$	-1.14		
$\text{Rh}^{2+} + 2e \rightleftharpoons \text{Rh}$	0.600	$\text{Te} + 2\text{H}^+ + 2e \rightleftharpoons \text{H}_2\text{Te}$	-0.79		
$\text{Rh}^{3+} + 3e \rightleftharpoons \text{Rh}$	0.758	$\text{Te}^{4+} + 4e \rightleftharpoons \text{Te}$	0.568		
$[\text{RhCl}_6]^{3-} + 3e \rightleftharpoons \text{Rh} + 6\text{Cl}^-$	0.431	$\text{TeO}_2 + 4\text{H}^+ + 4e \rightleftharpoons \text{Te} + 2\text{H}_2\text{O}$	0.593		
$\text{Ru}^{2+} + 2e \rightleftharpoons \text{Ru}$	0.455	$\text{TeO}_3^{2-} + 3\text{H}_2\text{O} + 4e \rightleftharpoons \text{Te} + 6\text{OH}^-$	-0.57		
$\text{Ru}^{3+} + e \rightleftharpoons \text{Ru}^{2+}$	0.2487	$\text{TeO}_4^{2-} + 8\text{H}^+ + 7e \rightleftharpoons \text{Te} + 4\text{H}_2\text{O}$	0.472		
$\text{RuO}_2 + 4\text{H}^+ + 2e \rightleftharpoons \text{Ru}^{2+} + 2\text{H}_2\text{O}$	1.120	$\text{H}_6\text{TeO}_6 + 2\text{H}^+ + 2e \rightleftharpoons \text{TeO}_2 + 4\text{H}_2\text{O}$	1.02		
$\text{RuO}_4^- + e \rightleftharpoons \text{RuO}_4^{2-}$	0.59	$\text{Th}^{4+} + 4e \rightleftharpoons \text{Th}$	-1.89		
$\text{RuO}_4 + e \rightleftharpoons \text{RuO}_4^-$	1.00	$\text{ThO}_2 + 4\text{H}^+ + 4e \rightleftharpoons \text{Th} + 2\text{H}_2\text{O}$	-1.78		
$\text{S} + 2e \rightleftharpoons \text{S}^{2-}$	-0.47627	$\text{Th(OH)}_4 + 4e \rightleftharpoons \text{Th} + 4\text{OH}^-$	-2.48		
$\text{S} + 2\text{H}^+ + 2e \rightleftharpoons \text{H}_2\text{S(aq)}$	0.142	$\text{Ti}^{2+} + 2e \rightleftharpoons \text{Ti}$	-1.63		
$\text{S} + \text{H}_2\text{O} + 2e \rightleftharpoons \text{HS}^- + \text{OH}^-$	-0.478	$\text{Ti}^{3+} + e \rightleftharpoons \text{Ti}^{2+}$	-0.368		
$2\text{S} + 2e \rightleftharpoons \text{S}_2^{2-}$	-0.42836	$\text{TiO}_2 + 4\text{H}^+ + 2e \rightleftharpoons \text{Ti}^{2+} + 2\text{H}_2\text{O}$	-0.502		
$\text{S}_2\text{O}_8^{2-} + 4\text{H}^+ + 2e \rightleftharpoons 2\text{H}_2\text{SO}_4$	0.564	$\text{TiOH}^{3+} + \text{H}^+ + e \rightleftharpoons \text{Ti}^{3+} + \text{H}_2\text{O}$	-0.055		
$\text{S}_2\text{O}_8^{2-} + 2e \rightleftharpoons 2\text{SO}_4^{2-}$	2.010	$\text{Ti}^+ + e \rightleftharpoons \text{Ti}$	-0.336		
$\text{S}_2\text{O}_8^{2-} + 2\text{H}^+ + 2e \rightleftharpoons 2\text{HSO}_4^-$	2.123	$\text{Ti}^+ + e \rightleftharpoons \text{Ti(Hg)}$	-0.3338		
$\text{S}_4\text{O}_8^{2-} + 2e \rightleftharpoons 2\text{S}_2\text{O}_8^{2-}$	0.08	$\text{Ti}^{3+} + 2e \rightleftharpoons \text{Ti}^+$	1.252		
$2\text{H}_2\text{SO}_3 + \text{H}^+ + 2e \rightleftharpoons \text{HSO}_4^- + 2\text{H}_2\text{O}$	-0.056	$\text{TlBr} + e \rightleftharpoons \text{Tl} + \text{Br}^-$	-0.658		
$\text{H}_2\text{SO}_3 + 4\text{H}^+ + 4e \rightleftharpoons \text{S} + 3\text{H}_2\text{O}$	0.449	$\text{TlCl} + e \rightleftharpoons \text{Tl} + \text{Cl}^-$	-0.5568		
$2\text{SO}_3^{2-} + 2\text{H}_2\text{O} + 2e \rightleftharpoons \text{S}_2\text{O}_4^{2-} + 4\text{OH}^-$	-1.12	$\text{TlI} + e \rightleftharpoons \text{Tl} + \text{I}^-$	-0.752		
$2\text{SO}_3^{2-} + 3\text{H}_2\text{O} + 4e \rightleftharpoons \text{S}_2\text{O}_3^{2-} + 6\text{OH}^-$	-0.571	$\text{Ti}_2\text{O}_3 + 3\text{H}_2\text{O} + 4e \rightleftharpoons 2\text{Ti}^+ + 6\text{OH}^-$	0.02		
$\text{SO}_4^{2-} + 4\text{H}^+ + 2e \rightleftharpoons \text{H}_2\text{SO}_3 + \text{H}_2\text{O}$	0.172	$\text{TIOH} + e \rightleftharpoons \text{Ti} + \text{OH}^-$	-0.34		
$2\text{SO}_4^{2-} + 4\text{H}^+ + 2e \rightleftharpoons \text{S}_2\text{O}_8^{2-} + \text{H}_2\text{O}$	-0.22	$\text{Ti(OH)}_3 + 2e \rightleftharpoons \text{TIOH} + 2\text{OH}^-$	-0.05		
$\text{SO}_4^{2-} + \text{H}_2\text{O} + 2e \rightleftharpoons \text{SO}_3^{2-} + 2\text{OH}^-$	-0.93	$\text{Ti}_2\text{SO}_4 + 2e \rightleftharpoons \text{Ti} + \text{SO}_4^{2-}$	-0.4360		
$\text{Sb} + 3\text{H}^+ + 3e \rightleftharpoons \text{SbH}_3$	-0.510	$\text{U}^{3+} + 3e \rightleftharpoons \text{U}$	-1.798		
$\text{Sb}_2\text{O}_3 + 6\text{H}^+ + 6e \rightleftharpoons 2\text{Sb} + 3\text{H}_2\text{O}$	0.152	$\text{U}^{4+} + e \rightleftharpoons \text{U}^{3+}$	-0.607		
$\text{Sb}_2\text{O}_3 \text{ (senarmontite)} + 4\text{H}^+ + 4e \rightleftharpoons 2\text{Sb} + 2\text{H}_2\text{O}$	0.671	$\text{UO}_2^{2+} + 4\text{H}^+ + e \rightleftharpoons \text{U}^{4+} + 2\text{H}_2\text{O}$	0.612		
$\text{Sb}_2\text{O}_3 \text{ (valentinite)} + 4\text{H}^+ + 4e \rightleftharpoons 2\text{Sb} + 2\text{H}_2\text{O}$	0.649	$\text{UO}_2^{2+} + e \rightleftharpoons \text{UO}^+$	0.062		
$\text{Sb}_2\text{O}_3 + 6\text{H}^+ + 4e \rightleftharpoons 2\text{SbO}^+ + 3\text{H}_2\text{O}$	0.581	$\text{UO}_2^{2+} + 4\text{H}^+ + 2e \rightleftharpoons \text{U}^{4+} + 2\text{H}_2\text{O}$	0.327		
$\text{SbO}^+ + 2\text{H}^+ + 3e \rightleftharpoons \text{Sb} + 2\text{H}_2\text{O}$	0.212	$\text{UO}_2^{2+} + 4\text{H}^+ + 6e \rightleftharpoons \text{U} + 2\text{H}_2\text{O}$	-1.444		
$\text{SbO}_2^- + 2\text{H}_2\text{O} + 3e \rightleftharpoons \text{Sb} + 4\text{OH}^-$	-0.66	$\text{V}^{2+} + 2e \rightleftharpoons \text{V}$	-1.175		
$\text{SbO}_3^- + \text{H}_2\text{O} + 2e \rightleftharpoons \text{SbO}_2^- + 2\text{OH}^-$	-0.59	$\text{V}^{3+} + e \rightleftharpoons \text{V}^{2+}$	-0.255		
$\text{Sc}^{3+} + 3e \rightleftharpoons \text{Sc}$	-2.077	$\text{VO}^{2+} + 2\text{H}^+ + e \rightleftharpoons \text{V}^{3+} + \text{H}_2\text{O}$	0.337		
$\text{Se} + 2e \rightleftharpoons \text{Se}^{2-}$	-0.924	$\text{VO}_2^+ + 2\text{H}^+ + e \rightleftharpoons \text{VO}^{2+} + \text{H}_2\text{O}$	0.991		
		$\text{V(OH)}_4^+ + 2\text{H}^+ + e \rightleftharpoons \text{VO}^{2+} + 3\text{H}_2\text{O}$	1.00		
		$\text{V(OH)}_4^+ + 4\text{H}^+ + 5e \rightleftharpoons \text{V} + 4\text{H}_2\text{O}$	-0.254		
		$\text{W}_2\text{O}_5 + 2\text{H}^+ + 2e \rightleftharpoons 2\text{WO}_2 + \text{H}_2\text{O}$	-0.031		

REDUCTION

$2\text{H}^+ + 2e \rightleftharpoons \text{H}_2$	0.00
$\text{CuI}_2 + e \rightleftharpoons \text{Cu} + \text{I}^-$	-0.86
$\text{Ge}^{4+} + 2e \rightleftharpoons \text{Ge}^2$	-0.60
$\text{NO}_3^- + \text{H}_2\text{O} + 2e \rightleftharpoons \text{NO}_2^- + \text{OH}^-$	0.01
$\text{Ti}_2\text{O}_3 + 3\text{H}_2\text{O} + 4e \rightleftharpoons 2\text{Ti} + 6\text{OH}^-$	-0.34
$\text{SeO}_4^{2-} + \text{H}_2\text{O} + 2e \rightleftharpoons \text{SeO}_3^{2-} + 2\text{OH}^-$	0.05
$\text{UO}_2^{2+} + e \rightleftharpoons \text{UO}_2^+$	0.062
$\text{Pd(OH)}_2 + 2e \rightleftharpoons \text{Pd} + 2\text{OH}^-$	0.07
$\text{AgBr} + e \rightleftharpoons \text{Ag} + \text{Br}^-$	-0.09
$\text{S}_4\text{O}_8^{2-} + 2e \rightleftharpoons 2\text{S}_2\text{O}_8^{2-}$	0.08
$\text{AgSCN} + e \rightleftharpoons \text{Ag} + \text{SCN}^-$	-0.09
$\text{N}_2 + 2\text{H}_2\text{O} + 6\text{H}^+ + 6e \rightleftharpoons 2\text{NH}_3 + 2\text{H}_2\text{O}$	0.00
$\text{HgO} + \text{H}_2\text{O} + 2e \rightleftharpoons \text{Hg} + 2\text{OH}^-$	0.09
$\text{Ir}_2\text{O}_3 + 3\text{H}_2\text{O} + 6e \rightleftharpoons 2\text{Ir} + 6\text{OH}^-$	0.00
$2\text{NO} + 2e \rightleftharpoons \text{N}_2 + \text{O}_2$	0.00
$[\text{Co(NH}_3)_6]^{3+} + e \rightleftharpoons [\text{Co(NH}_3)_6]^{2+}$	0.01
$\text{Hg}_2\text{O} + \text{H}_2\text{O} + 2e \rightleftharpoons 2\text{Hg} + 2\text{OH}^-$	0.00
$\text{Ge}^{4+} + 4e \rightleftharpoons \text{Ge}$	-0.50
$\text{Hg}_2\text{Br}_2 + 2e \rightleftharpoons 2\text{Hg} + 2\text{Br}^-$	-0.08
$\text{Pt(OH)}_2 + 2e \rightleftharpoons \text{Pt} + 2\text{OH}^-$	0.00
$\text{S} + 2\text{H}^+ + 2e \rightleftharpoons \text{H}_2$	0.00
$\text{Np}^{4+} + e \rightleftharpoons \text{Np}^{3+}$	-0.05
$\text{Ag}_4[\text{Fe(CN)}_6] + 4e \rightleftharpoons 4\text{Fe(CN)}_6^{4-}$	-0.05
$\text{IO}_3^- + 2\text{H}_2\text{O} + 4e \rightleftharpoons \text{I}^- + 4\text{OH}^-$	-0.94
$\text{Mn(OH)}_3 + e \rightleftharpoons \text{Mn(OH)}_2 + \text{OH}^-$	0.00
$2\text{NO}_2^- + 3\text{H}_2\text{O} + 2e \rightleftharpoons \text{N}_2\text{O} + 4\text{OH}^-$	-0.02
$\text{Sn}^{4+} + 2e \rightleftharpoons \text{Sn}^{2+}$	-0.14
$\text{Sb}_2\text{O}_3 + 6\text{H}^+ + 6e \rightleftharpoons 2\text{Sb} + 3\text{H}_2\text{O}$	0.15
$\text{Cu}^{2+} + e \rightleftharpoons \text{Cu}^+$	0.16
$\text{BiOCl} + 2\text{H}^+ + 2e \rightleftharpoons \text{Bi} + \text{Cl}^-$	0.00
$\text{Bi(ClO}_4)_3 + 3e \rightleftharpoons \text{Bi} + 3\text{ClO}_4^-$	0.00
$\text{Co(OH)}_3 + e \rightleftharpoons \text{Co(OH)}_2 + \text{OH}^-$	0.00
$\text{SO}_4^{2-} + 4\text{H}^+ + 2e \rightleftharpoons \text{H}_2\text{SO}_3 + \text{H}_2\text{O}$	0.17
$\text{SbO}^+ + 2\text{H}^+ + 3e \rightleftharpoons \text{Sb} + 2\text{H}_2\text{O}$	0.21
$\text{AgCl} + e \rightleftharpoons \text{Ag} + \text{Cl}^-$	-0.22
$\text{As}_2\text{O}_3 + 6\text{H}^+ + 6e \rightleftharpoons 2\text{As} + 3\text{H}_2\text{O}$	0.00
$\text{Calomel electrode, } \text{Hg}_2\text{Cl}_2 + 2\text{H}^+ + 2e \rightleftharpoons 2\text{Hg} + 2\text{Cl}^-$	0.00
$\text{Ge}^{2+} + 2e \rightleftharpoons \text{Ge}$	-0.50
$\text{Calomel electrode, } \text{Hg}_2\text{Cl}_2 + 2\text{H}_2\text{O} + 2e \rightleftharpoons 2\text{Hg} + 2\text{Cl}^- + 2\text{OH}^-$	-0.27
$\text{HAsO}_2 + 3\text{H}^+ + 3e \rightleftharpoons \text{As} + 2\text{H}_2\text{O}$	0.00
$\text{Ru}^{3+} + e \rightleftharpoons \text{Ru}^{2+}$	0.00
$\text{ReO}_2 + 4\text{H}^+ + 4e \rightleftharpoons \text{Re} + 2\text{H}_2\text{O}$	0.00
$\text{IO}_3^- + 3\text{H}_2\text{O} + 6e \rightleftharpoons \text{I}^- + 6\text{OH}^-$	-0.94
$\text{Hg}_2\text{Cl}_2 + 2e \rightleftharpoons 2\text{Hg} + 2\text{Cl}^-$	0.00
$\text{Calomel electrode, } \text{Hg}_2\text{Cl}_2 + 2\text{H}_2\text{O} + 2e \rightleftharpoons 2\text{Hg} + 2\text{Cl}^- + 2\text{OH}^-$	-0.27
$\text{Calomel electrode, } \text{Hg}_2\text{Cl}_2 + 2\text{H}^+ + 2e \rightleftharpoons 2\text{Hg} + 2\text{Cl}^-$	0.00